OBSERVATIONS OF THE LEONIDS OVER THE LAST MILLENIUM

STEVEN J. DICK
US Naval Observatory
Washington DC 20392

1. Introduction

The recognition of the astronomical origin of meteors is intimately connected to the Leonid meteors, and their tendency to "storm" with a period of 33 years. It was the Leonid storm of 1799, observed by Alexander von Humboldt among others, that first established the geographical extent of the phenomenon, with observations reported over 90 degrees of longitude and 60 degrees of latitude. During the 1833 storm, Olmsted (1834) at Yale and Twining (1834) at West Point established the radiant point in Leo, and the cosmic origin was clinched when H. A. Newton (1863), also at Yale, determined that the cycle repeated in intervals of sidereal years, not tropical years. Inspired by the 1866 storm, Adams (1866), Schiaparelli (1867), and Le Verrier (1867) determined a 33.25 year period and other orbital elements for the meteor stream; two years after the discovery of Comet Tempel-Tuttle in 1865, that comet was recognized as the parent body of the Leonid stream after von Oppolzer (1867) calculated a period of 33.17 years for the comet. Astronomers confidently predicted another storm in 1899, but none appeared, though there were good showers in 1901-1903. The years 1930-32 also brought fairly good showers, but 1966 brought the strongest storm witnessed in modern times, with an estimated 100,000 meteors per hour. Steady progress was made in meteor studies in the 20th century, especially with new photographic and radar techniques. The current question is what will happen in the 1997-1999 period; the only certainty is that the event will be studied with an even wider array of techniques.

Our knowledge of the Leonid meteor stream might have remained limited had it not been for the recognition that historical observations could be a substantial aid. Catalogues of "falling stars" had been compiled at least as early as A. Quetelet's Catalogue des Principales Apparitions d'etoiles filantes in 1839. Already in 1863 Newton had identified six historical Leonid events (including what is now believed to be the earliest in 902 AD), and by the following year Newton (1864) had found 13, many of these showers rather than storms. The sources of these observations were varied and uneven in their detail and reliability; the 902 event was briefly but memorably described in a certain Historia de la Dominacion de los Arabes en Espana, along with several other sources. For this and other meteor claims, independent accounts from various sources leave no doubt of a memorable event, though quantitative rates, radiants and other parameters are lacking. Progress in finding more historical accounts was slow in the first half of the 20th century; the catalogue of meteor showers of Imoto and Hasegawa (1958) listed a total of only 18 Leonid events. The second half of the century has been a different story, however. Hasegawa (1993) listed 48 Leonid events, and Mason (1995) lists 58, of which 23 were probable storms. Hasegawa (1993) incorporated Chinese records compiled by Zhuang Tian-Shan (1966 and 1977) and Beijing Observatory (1988), and European records (Dall'olmo, 1978). Rada and Stephenson (1992) analyzed medieval Arab chronicles, and based on their work Kidger (1993) identified seven possible Leonid events, including possibly the earliest event in 855 AD.

All of this work is subject to interpretation, not least in dating problems including conversions among the calendars of different cultures, an essential determination if an event is to be classified as a Leonid at all. Still there is no doubt that the historical observations have contributed to our knowledge of the dynamical and physical nature of meteor streams (Stohl and Williams, 1993). Studies such as Yeomans (1981) have used observations from the interval 902-1969 to map the

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distribution of dust surrounding comet Tempel-Tuttle, to predict the strength of the Leonid event in 1998-99, and to redetermine the orbit of Tempel-Tuttle.

The study of meteors, and particularly the Leonid meteor story, is an excellent example of how historical data may be applied to modern astronomical problems. At the next General Assembly, Commission 41 (History of Astronomy) hopes to sponsor a Joint Discussion reviewing the broad array of modern astronomical problems to which historical data may be applied. By that time, whatever happens with the Leonids in 1997-99 will be history - one more data point for the applied historical astronomy of the future.

I am especially indebted to the comprehensive review of Mason (1995).

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